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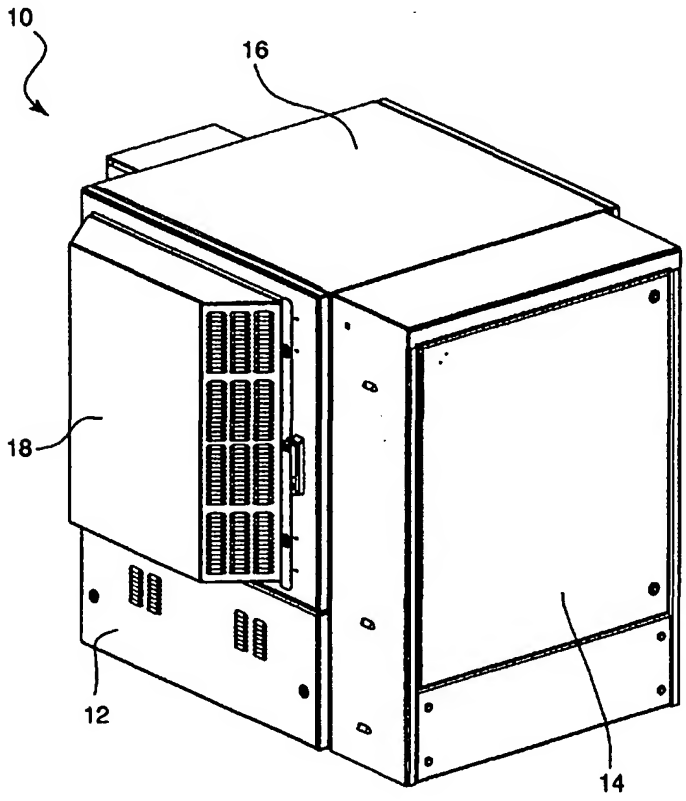
(54) Title: HEAT EXCHANGER FOR SEALED CABINETS



(57) Abstract: An electrical equipment cabinet is provided to contain heat-generating electrical equipment. The cabinet includes an enclosure having at least one access opening and a door providing a closure for the access opening. When open, the door permits access to the electrical equipment and when closed maintains a substantially closed environment in the interior of the cabinet. An air-to-air crossflow heat exchanger is removably engaged with and supported by the door for removing heat from the interior of the cabinet while maintaining the substantially closed environment within the cabinet. The heat exchanger defines a first air flow path for air drawn from the exterior of the cabinet and a second air flow path for air drawn from the interior of the cabinet. The first and second air flow paths are perpendicular to, and substantially isolated from, one another. A fan is mounted in an interior region of the door for circulating air through at least one of the first and second air flow paths.

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HEAT EXCHANGER FOR SEALED CABINETS

FIELD OF THE INVENTION

The present invention relates to an electrical equipment cabinet or the like, in which an air-to-air heat exchanger is used for cooling the equipment in the cabinet. More specifically, the invention relates to an electrical cabinet having a modular, crossflow heat exchanger mounted on the cabinet door.

BACKGROUND OF THE INVENTION

Outdoor electrical equipment cabinets are often used to protect sensitive electronic equipment such as telecommunications equipment from tampering, vandalism and adverse environmental conditions. The electronic components housed in the cabinets produce heat when operating. Therefore, a cooling system is required to remove the heat from the cabinets. As the electronic components become smaller and operate at higher power densities, cabinets need to dissipate heat more efficiently.

One example of a conventional outdoor electrical equipment cabinet is disclosed in U.S. 4,535,386 (Frey, Jr. et al.). This cabinet employs a heat exchanger to dissipate internally generated heat. The heat exchanger exchanges heat between the air in the cabinet and the ambient air outside the cabinet, without allowing the interior and ambient air to mix. In this way, a substantially closed or sealed environment can be maintained within the cabinet, while still allowing for adequate heat dissipation. The heat exchanger is located in the main portion of the cabinet, in proximity to the electronics requiring cooling. However, the presence of the heat exchanger in the cabinet can interfere with the cables used to interconnect the various electronic components, making the routing of these cables somewhat more difficult. Also, since the heat exchanger occupies a significant amount of space, the cabinet must usually be made larger to accommodate it.

U.S. 5,467,250 (Howard et al.) discloses an electrical equipment cabinet that employs a door-mounted heat exchanger so that the heat exchanger does not occupy internal space required for the electrical equipment while maintaining a closed or sealed environment within the cabinet. An arrangement of ducts and vents is used to force interior and exterior air through channels in the heat

exchanger using powered fans mounted within the main portion of the cabinet. The mounting of the heat exchanger on or within the door of the cabinet makes more efficient use of the space available within the cabinet.

However, the heat exchanger employed in Howard et al. is a parallel flow heat exchanger in which the channels conducting interior air are parallel to the channels conducting exterior air. The housing in which the heat exchanger is located contains two sets of interdigitated vents for conducting internal and external air through the heat exchanger. In order to ensure that the flow of exterior air remains isolated from the flow of interior air, each set of interdigitated vents must be in precise registration with either the channels conducting interior air or the channels conducting exterior air. One problem with this arrangement is that its manufacturing and assembly is difficult because of the precise tolerances involved.

There is thus a need in the art for a heat exchanger adapted for use in electrical equipment cabinets which is easy to assemble and which is not dependent on stringent manufacturing tolerances. These and other needs are met by the present invention, as hereinafter described.

SUMMARY OF THE INVENTION

In accordance with the present invention, an electrical equipment cabinet is provided to contain heat-generating electrical equipment. The cabinet includes an enclosure having at least one access opening and a door providing a closure for the access opening. When open, the door permits access to the electrical equipment and when closed maintains a substantially closed environment in the interior of the cabinet. An air-to-air crossflow heat exchanger is removably engaged with and supported by the door for removing heat from the interior of the cabinet while maintaining the substantially closed environment within the cabinet. The heat exchanger defines a first air flow path for air drawn from the exterior of the cabinet and a second air flow path for air drawn from the interior of the cabinet. The first and second air flow paths are perpendicular to, and substantially isolated from, one another. A fan element is mounted in an interior region of the door for circulating air through at least one of the first and second air flow paths.

In accordance with one aspect of the invention, the fan element includes a pair of fans located adjacent to one another. In some embodiments, a baffle is

located between the pair of fans for dividing the flow path into two parallel air flow paths that are substantially isolated from one another.

In accordance with another aspect of the invention, the cabinet also includes upper and lower air flow plenums, which are mounted to an interior surface of the door. The cross-flow heat exchanger element is supported between the air flow plenums in a removably engagable manner.

In accordance with yet another aspect of the invention, the door includes first and second external air vents conducting external air through one of the air flow paths.

In accordance with another aspect of the invention, the door includes a panel separating the interior region of the door and the interior of the enclosure when the door is closed. The panel may include first and second interface slots for conducting air from the interior of the enclosure to one of the air flow paths and not the other air flow path.

In accordance with another aspect of the invention, a third fan is mounted in the interior of the door for circulating air through the other of the first and second air flow paths. The third fan may include a second pair of fans located adjacent to one another.

In accordance with yet another aspect of the invention, a second baffle is located between the second pair of fans for dividing the other of the first and second air flow paths into two parallel air flow paths that are substantially isolated from one another.

In accordance with another aspect of the invention, at least one baffle is provided for mixing air conducted out of the outflow openings of the heat exchanger so that the temperature uniformity of air in the second air flow path is enhanced. The baffle may be integrated with the lower air flow plenum.

In accordance with another aspect of the invention, the fan is mounted on a surface of the heat exchanger such as the intake or outflow surface of said heat exchanger.

In accordance with another aspect of the invention, an interior region of the door extends outward from the enclosure so that the enclosure does not include the

interior region of the door. Alternatively, the interior region of the door may be located substantially within the enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an outdoor electrical cabinet incorporating a door-mounted, air-to-air heat exchanger in accordance with the present invention.

FIG. 2 is an exploded perspective view of the modular heat exchanger, including the cross-flow core, fans, and an external circuit air filter.

FIG. 3 shows an exemplary cross-flow heat exchanger core that may be employed in the present invention.

FIG. 4 is an assembled view of the modular heat exchanger shown in FIG. 2.

FIG. 5 shows the housing outer shell of an alternative embodiment of the invention in which baffles are employed to enhance thermal mixing of the interior air flow.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates an outdoor electrical equipment cabinet **10** incorporating a door-mounted, air-to-air heat exchanger in accordance with the present invention. The cabinet includes a base **12**, side walls **14**, a roof **16**, and the door/heat exchanger unit **18**. The cabinet contains a number of equipment racks or channel banks (not shown), which are located on shelves provided in the cabinet. The interior of the door contains an air-to-air crossflow heat exchanger, which will be described in detail shortly, for exchanging heat between the interior and exterior of the cabinet.

FIG. 2 shows an exploded perspective view of the door/heat exchanger unit, which includes housing outer shell **20** and door panel **22**. The assembled unit is shown in FIG. 4. Housing outer shell and panel join together to form an interior space in which an inner housing is located. Housing outer shell includes inflow vents **24** and outflow vents **26**. The inner housing, which contains heat exchanger **28**, includes intake plenum **21** and exhaust plenum **23** that are mounted to the housing outer shell. The plenums **21** and **23** extend toward the interior of the

housing outer shell and are configured so that the heat exchanger can be retained and supported therein in a conveniently removable manner.

In the embodiment of the invention depicted in FIGS. 1 and 2, the interior space of the door/heat exchanger unit extends outward from the cabinet so that the interior space of the door/heat exchanger unit is separate and apart from the cabinet interior, where the electrical equipment is located. This arrangement maximizes the space within the cabinet interior reserved for electrical equipment, and is also advantageous because the heat exchanger can be serviced without accessing the cabinet interior. In other embodiments of the invention, however, the interior space of the door/heat exchanger unit is located within the interior of the cabinet. This arrangement may be preferred when the interior space reserved for electrical equipment does not need to be maximized with respect to the overall exterior dimensions of the cabinet.

The single-pass cross-flow heat exchanger element **28** is of conventional design, being formed from a dip-brazed arrangement of folded aluminum sheets separated by flat plates. As best seen in FIG. 3, the crossflow heat exchanger element has alternating layers of vertical channels **43** and horizontal channels **45**. Each layer includes a multiplicity of channels. The vertical channels terminate in two planes, only one of which is visible in FIGS. 2 and 3, which respectively contain inflow and outflow openings. In FIG. 2, the inflow openings of the vertical channels are generally denoted by reference numeral **47**. The horizontal channels also terminate in two planes, only one of which is visible in FIGs. 2 and 3, which respectively contain inflow and outflow openings. In FIG. 2, the outflow openings of the horizontal channels are generally denoted by reference numeral **48**. The vertical and horizontal channels are physically isolated from one another so that air flowing in the vertical channels is physically isolated from air flowing in the horizontal channels. A heat conductive sheet separates the vertical and horizontal channels from one another so that they are in good thermal contact with one another.

The heat exchanger element **28** is situated in the plenums so that the inflow vents **24** of the outer housing shell **20** are aligned with the inflow openings of the horizontal channels **45** of the heat exchanger element. The heat exchange element

is provided with a retainer plate 27. Likewise, the outflow vents **26** of the outer housing shell **20** are aligned with the outflow openings of the horizontal channels **45** of the heat exchanger. Accordingly, the horizontal channels are exposed to air outside the sealed cabinet. The cabinet is provided with a filter **29** to remove contaminants from the outside air. The filter is secured in place in a filter channel having a top **61** and a bottom **63** (see FIG. 5). The cabinet may also be provided with an insect screen angle **71**.

Panel **22** includes a first interface slot **35** for conducting internal air from the interior of the cabinet **10** to the inflow openings of the vertical channels **43** of the heat exchanger **28**. Panel **22** also includes a second interface slot **37** for conducting internal air from the outflow openings of the vertical channels **43** of the heat exchanger **28** back into the interior of the cabinet **10,** and a latch assembly **26** for securing the panel to the cabinet.

A first pair of fans **50** is mounted to the intake side **47** of the vertical channels **43** to draw internal air into the heat exchanger and force it through the vertical channels **43**. Likewise, a second pair of fans **52** is mounted to the output side **48** of the horizontal channels **45** to draw external air through the horizontal channels.

In operation, air exterior to the cabinet **10** is drawn through the intake vents **24** of outer housing shell **20** so that external air flows into the horizontal channels **45**. The air exits the horizontal channels **45** and flows through output vents **26** of outer housing shell **20** to exit the cabinet **10**.

Internal air containing heat generated by the electrical equipment within the cabinet **10** is drawn into the intake openings of the vertical channels **43** of the heat exchanger element **28**. The internal air is conducted through the vertical channels **43** and exits the heat exchanger via the output openings of the vertical channels **43**. In this way the heat contained in the internal air is transferred to the outside air flowing through the horizontal channels **45** of the heat exchanger element **28** by the combination of forced convection and conductive heat transfer.

From the foregoing description, it will be appreciated that a continuous re-circulating flow of interior air is maintained through the equipment located in the cabinet **10**, interface slots **35** and **37**, and the vertical channels **43** of the heat

exchanger element **28**. At the same time, a separate flow or circuit of outside air is drawn in through the vents **24** of the outer housing shell **20**, forced through the heat exchanger element **28** by means of the fans, and then passes out of the cabinet **10** through the vents **26** in outer housing shell **20**. Since the internal and external flow circuits are isolated from each other and do not mix, the environment within the cabinet **10** remains sealed while heat is removed from the interior of the cabinet by means of the heat exchanger element **28**.

To ensure that the outside circuit of air does not mix with the internal circuit of air, the inner housing (which includes intake plenum **21**, exhaust plenum **23**, heat exchanger element **28** and panel **22**) may be provided with a sealant that prevents leakage of air between the terminal ends of the horizontal and vertical channels. The sealant, which may be a silicon compound, for example, should be provided along the lines where the plenums, heat exchanger element and panel 22 meet.

In one embodiment of the invention, the vertical (internal) circuit of air is separated into two air flows that operate in parallel with one another. In FIG. 2, this is accomplished by integrating a baffle **39** with the air intake plenum **21**. When the heat exchanger **28** is placed between the plenums **21** and **23**, baffle **39** contacts the inflow openings of the vertical channels **43** of the heat exchanger, dividing the vertical channels **43** into two sets.

The baffle **39** prevents air from being communicated between the two sets of channels, thereby creating in effect two parallel circuits of air that flow through the vertical channels **43** independently of one another. The horizontal, or external, circuit of air may also be divided into two parallel circuits in the same manner as the internal circuit. For example, as shown in FIG. 2, a baffle **41** is located between the individual fans in the second pair of fans **52** to create two separate and independent flow paths for the external air flow circuit.

By dividing the horizontal and vertical circuits of air into two discrete parallel flow paths, the present invention advantageously remains effective even if one of the fans in each set should fail. For example, if one of the fans that force air through the vertical channels should fail, the circuit of air associated with the remaining operable fan will continue to flow normally. Accordingly, the failure of

a single fan will only reduce the performance of the heat exchanger by about 50%. On the other hand, if a fan should fail in absence of baffle **39**, the performance of the heat exchanger will be reduced by much more than 50% because the inoperable fan effectively "short-circuits" the operating fan's normal draw of air (flow path). In this case the air would uselessly re-circulate through the operating fan while back-flowing through the inoperable fan; virtually no air flow would be forced through the vertical channels, and the performance reduction of the heat exchanger would approach 100%.

It is common in single-pass cross-flow heat exchangers for the air to exit the heat exchanger element with a non-uniform temperature distribution. This is because the majority of heat transfer occurs near the inlets of the external flow circuit in the heat exchanger element, where the external air flow is the coolest.

If, in the electronics cabinet, the air travels only a short distance between the second interface slot **37** and the electronics rack being cooled, there is insufficient thermal mixing and this non-uniform temperature profile can persist into the electronics rack. As a result, one side of the electronics rack will receive warmer air than the other and the electronic equipment on that side will not be as effectively cooled.

In an embodiment of the invention shown in FIG. 5, the exhaust plenum **23** includes three baffles $\mathbf{40_1}$, $\mathbf{40_2}$ and $\mathbf{40_3}$ to ameliorate this problem. The baffles $\mathbf{40_1}$, $\mathbf{40_2}$ and $\mathbf{40_3}$ are designed to promote mixing and a more uniform temperature profile at the exhaust slot. In FIG. 5, rear baffle $\mathbf{40_1}$ is biased against the wall of the exhaust plenum **23** nearest the inflow vents **24** and extends at least halfway to the opposing wall of the exhaust plenum **23**. The two front baffles $\mathbf{40_2}$ and $\mathbf{40_3}$ are equal in size and have a length that is less than the rear baffle $\mathbf{40_1}$. The baffles $\mathbf{40_2}$ and $\mathbf{40_3}$ are symmetrically located against the opposing walls of the exhaust plenum **23**. Computer simulations have been performed which demonstrate that this arrangement of baffles results in a flow of internal air that has a more uniform temperature profile as it returns to the interior of the cabinet via the second interface slot **37**. Of course, the present invention is not limited to the number or arrangement of air-mixing baffles **40** shown in FIG. 5. Rather, the present invention contemplates the provision of any number and arrangement of air-mixing

baffles **40**, the size and location of which may be empirically determined for any given application to achieve the desired degree of temperature uniformity within the electronics cabinet.

The three baffles **40** in the exhaust plenum **23** also serve a second purpose in that they also help to retain and support the weight of heat exchanger element **28**, which in some configurations may weigh upwards of **50** pounds.

The preceding description of the present invention is merely illustrative, and is not intended to be limiting. Therefore, the scope of the present invention should be construed solely by reference to the appended claims.

What is claimed is:

1. In an electrical equipment cabinet that includes an enclosure adapted to contain heat-generating electrical equipment and a door providing a closure for an access opening into the enclosure, a heat exchanger arrangement, comprising:

an air-to-air crossflow heat exchanger removably engaging with, and being supported by, the door for removing heat from the interior of said cabinet while maintaining a substantially closed environment within said cabinet, said heat exchanger defining a first air flow path for air drawn from the exterior of said cabinet and a second air flow path for air drawn from the interior of said cabinet, said first and second air flow paths being perpendicular to one another and substantially isolated from each other; and

at least one fan mounted within the door for circulating air through at least one of said first and second air flow paths.

2. The heat exchanger arrangement of claim 1, comprising a pair of fans located adjacent to one another, and a baffle located between said pair of fans for dividing the at least one flow path into two parallel air flow paths substantially isolated from one another.

3. The heat exchanger arrangement of claim 1, further comprising upper and lower air flow plenums mountable to an interior surface of the door, said cross-flow heat exchanger element being supported between said air flow plenums in a removably engagable manner.

4. The heat exchanger arrangement of claim 1, wherein said door includes first and second external air vents conducting external air through one of said air flow paths.

5. The heat exchanger arrangement of claim 1, wherein said fan circulates air through the first air flow path.

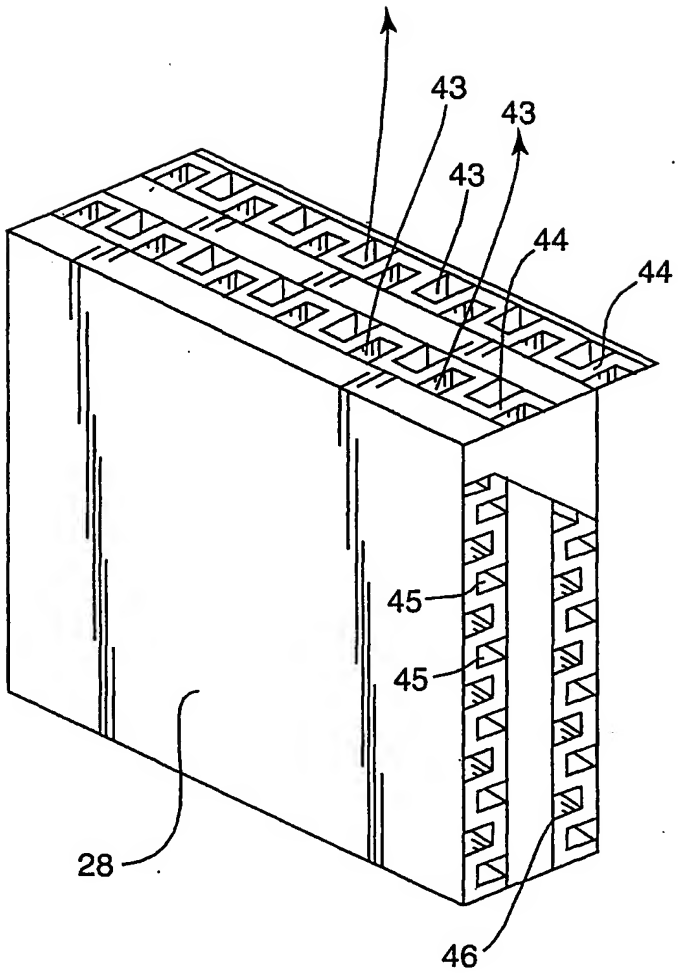


FIG. 3

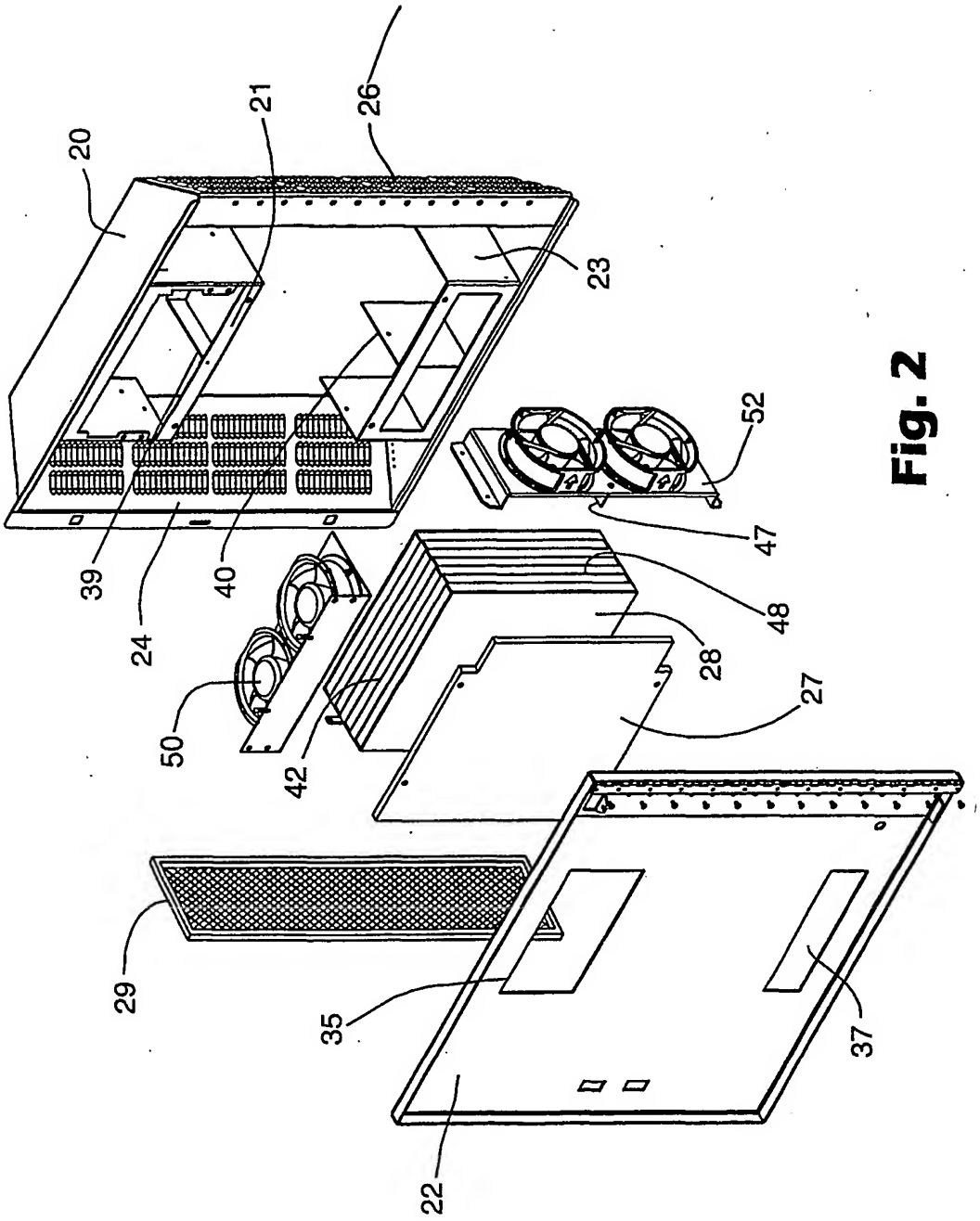


Fig. 2

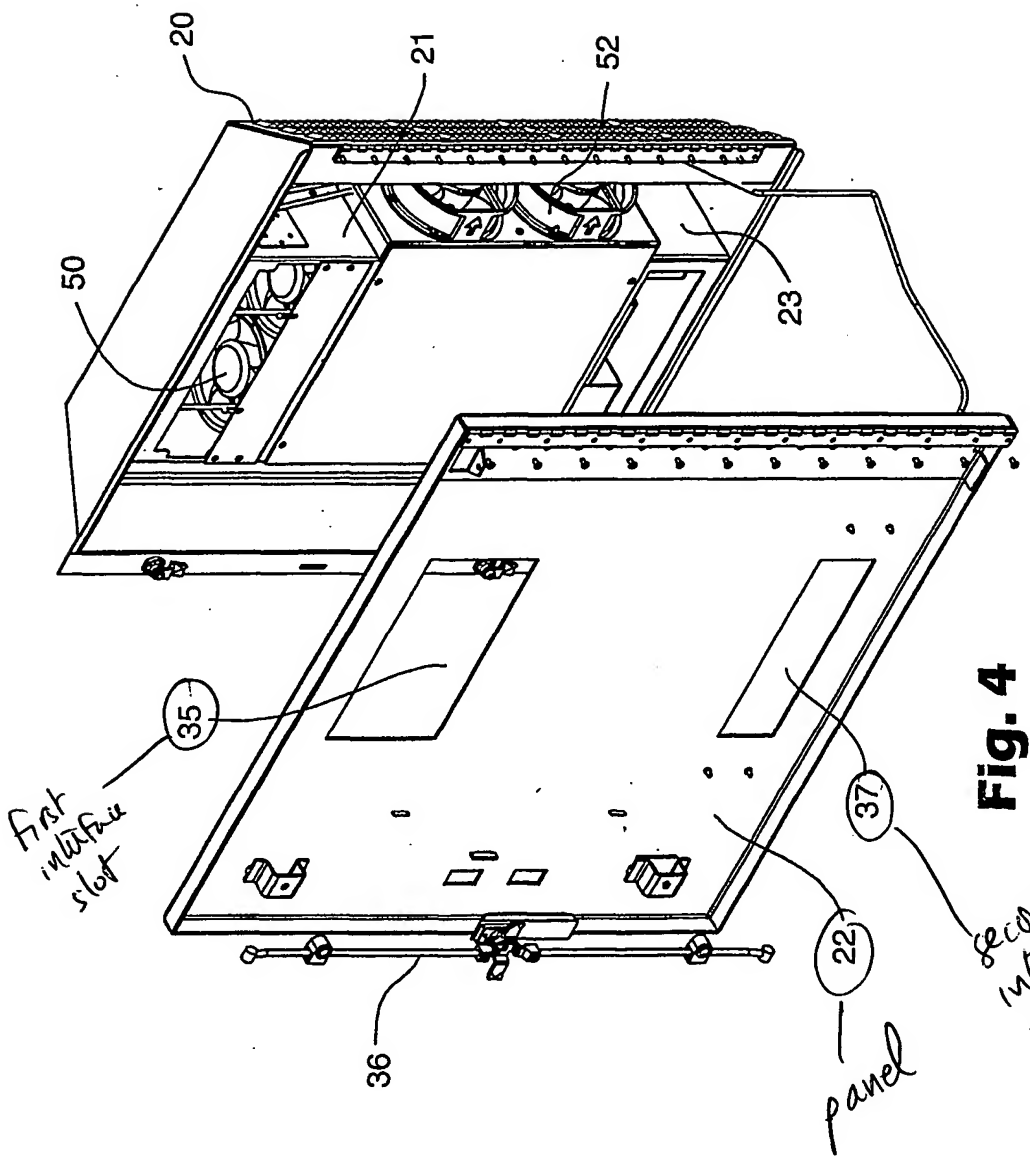

20
21
52
50
23
35
first interface slot
37
second interface slot.
22
panel
36

Fig. 4

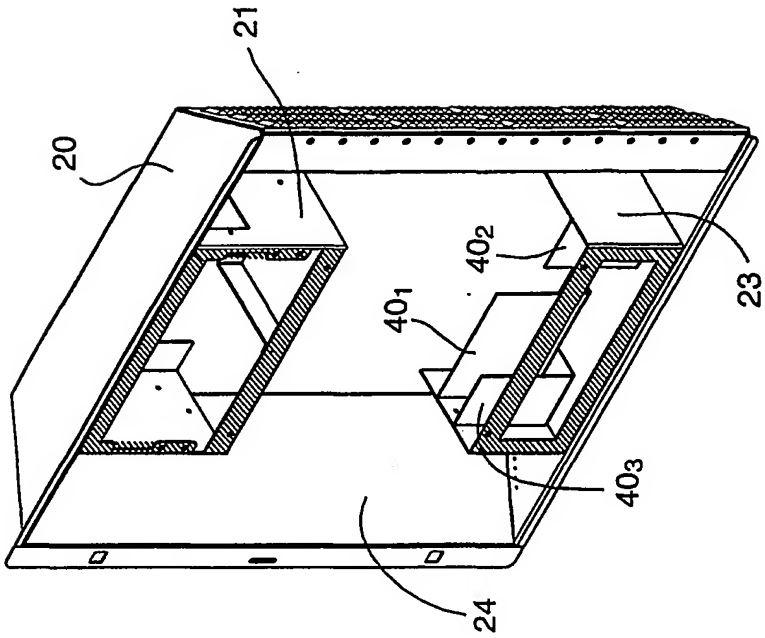
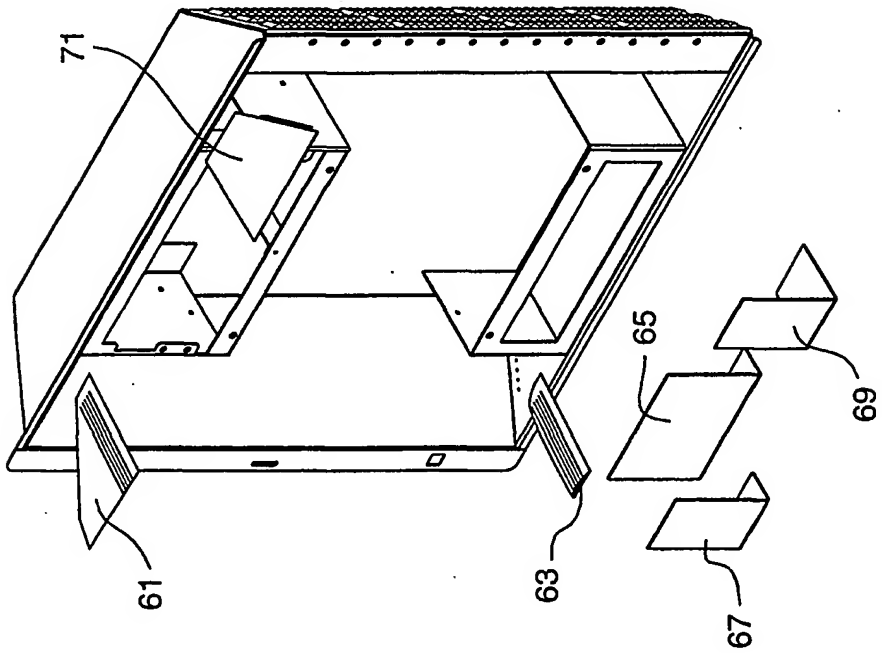


Fig. 5



INTERNATIONAL SEARCH REPORT

Inter al Application No
PCT/US 01/15267

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05K7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 054 545 A (GHAEMIAN ALLEN) 8 October 1991 (1991-10-08)	1,2
A	column 3, line 59 -column 4, line 16; figures 5,7	3-10
Y	FR 2 078 558 A (SIEMENS AG) 5 November 1971 (1971-11-05) page 3, line 12 -page 4, line 29; figures 1,2	1,2
A	page 6, line 2 - line 8	3-10
A	EP 0 312 372 A (BICC PLC) 19 April 1989 (1989-04-19) column 4, line 30 - line 62; figure 1	1-10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 January 2002	14/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Rubenowitz, A

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 467 250 A (HOWARD PAUL A ET AL) 14 November 1995 (1995-11-14) cited in the application column 4, line 59 -column 5, line 43; figure 1 -----	1-10

INTERNATIONAL SEARCH REPORT

ormation on patent family members

Inte ıal Application No
PCT/US 01/15267

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5054545 A	08-10-1991	CA 2055083 A1	05-06-1992
FR 2078558 A	05-11-1971	DE 2006759 A1	26-08-1971
		AT 303814 B	15-11-1972
		CH 525598 A	15-07-1972
		ES 194564 Y	16-04-1975
		FR 2078558 A5	05-11-1971
		HU 162661 B	28-03-1973
		ZA 7100670 A	27-10-1971
EP 0312372 A	19-04-1989	AT 77529 T	15-07-1992
		AU 599841 B2	26-07-1990
		AU 2390088 A	20-04-1989
		CA 1289759 A1	01-10-1991
		DE 3872154 D1	23-07-1992
		DK 574988 A	16-04-1989
		EP 0312372 A2	19-04-1989
		FI 884706 A	16-04-1989
		GB 2211361 A ,B	28-06-1989
		NO 884583 A	17-04-1989
		NZ 226558 A	26-02-1990
		US 4911231 A	27-03-1990
US 5467250 A	14-11-1995	NONE	

6. The heat exchanger arrangement of claim 2, wherein said pair of fans circulate air through the second air flow path.

7. The heat exchanger arrangement of claim 3, further comprising a third fan mounted in the interior of the door for circulating air through the other of the first and second air flow paths.

8. The heat exchanger arrangement of claim 7, wherein said third fan comprises a second pair of fans located adjacent to one another, and a second baffle located between said second pair of fans for dividing said other of the first and second air flow paths into two parallel air flow paths substantially isolated from one another.

9. The heat exchanger arrangement of claim 1, wherein said heat exchanger has intake and outflow openings located in said second air flow path, and further comprising at least one baffle for mixing air conducted out of the outflow openings of the heat exchanger so that temperature uniformity of air in the second air flow path is enhanced.

10. The heat exchanger arrangement of claim 4, wherein said heat exchanger has intake and outflow openings located in said second air flow path, and further comprising at least one baffle for mixing air conducted out of the outflow openings of the heat exchanger so that temperature uniformity of air in the second air flow path is enhanced.

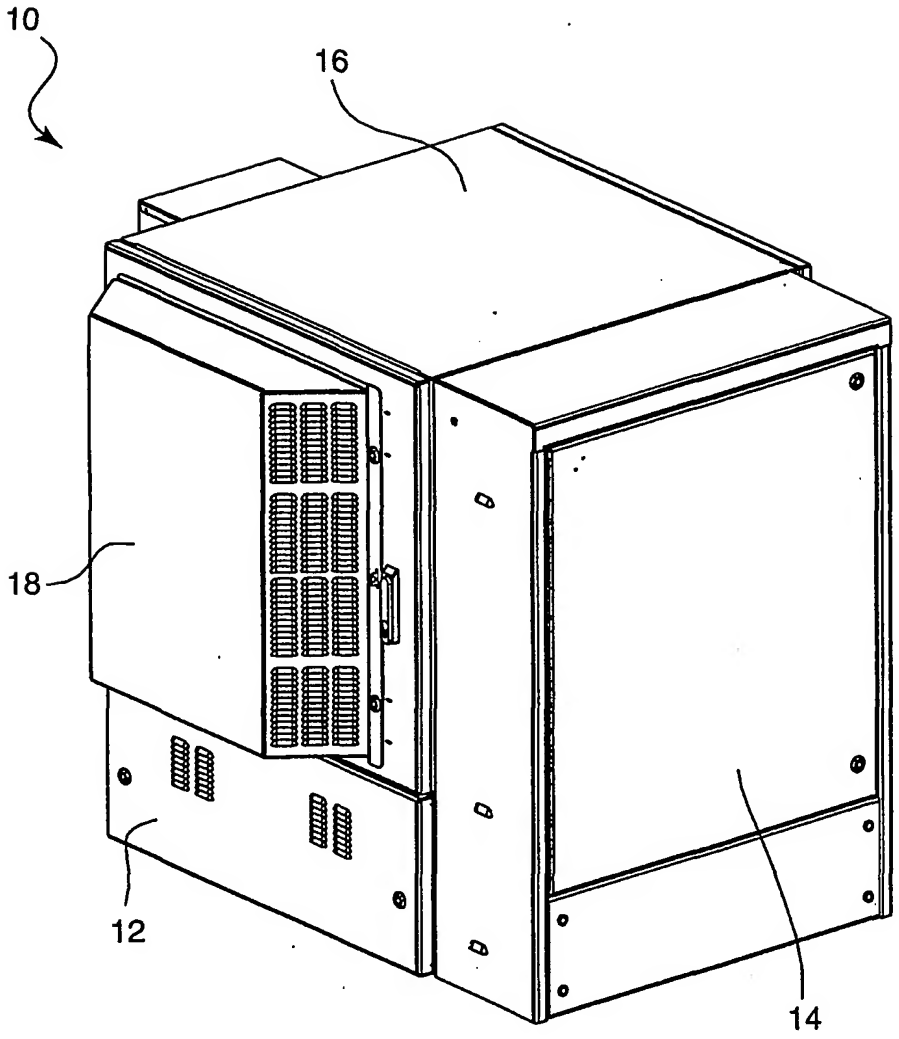

Fig. 1